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SWRHL-18r

FINAL REPORT OF OFF-SITE SURVEILLANCE FOR THE NRX-A3 EXPERIMENT

by the
Southwestern Radiological Health Laboratory
U. S. Public Health Service
Department of Health, Education, and Welfare
Las Vegas, Nevada

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ABSTRACT

The Southwestern Radiological Health Laboratory provided off-site radiation surveillance in support of the NRX-A3 experiments of April 23, May 20 and May 28, 1965. This support consisted of tracking the effluent, monitoring radiation dosage to the off-site population and collecting environmental samples in downwind areas. Although off-site contamination occurred as a result of the NRX-A3 tests, the data collected indicate that radioactivity levels did not exceed the safety criteria established by the Atomic Energy Commission for the off-site population.

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INTRODUCTION

As a part of the ROVER Program, testing and disassembling of a series of reactors designated NRX-A is being conducted under the Nuclear Engine for Rocket Vehicle Application (NERVA) Project at the Nuclear Rocket Development Station. The subject of this report is the off-site surveillance provided by the Public Health Service (PHS) for the Atomic Energy Commission (AEC) in support of the NRX-A3. Experimental Plans 4, 5 and 6 were conducted at Test Cell A on April 23, May 20 and May 28, 1965. The results of each test will be discussed in a separate section of this report. The reactor was tested in an upright position so that the hydrogen coolant exhausted upward along with escaping fission products (see Figure 1).

Under a Memorandum of Understanding with the Atomic Energy Commission, the U. S. Public Health Service conducts a program of radiological monitoring and environmental sampling in the off-site area surrounding the Nevada Test Site and the Nellis Air Force Range. The overall complex of the Nevada Test Site (NTS) and the Nellis Air Force Range (NAFR) includes the Nuclear Rocket Development Station (NRDS) and the Tonopah Test Range (TTR) and for simplicity will be called the test range complex throughout this report.

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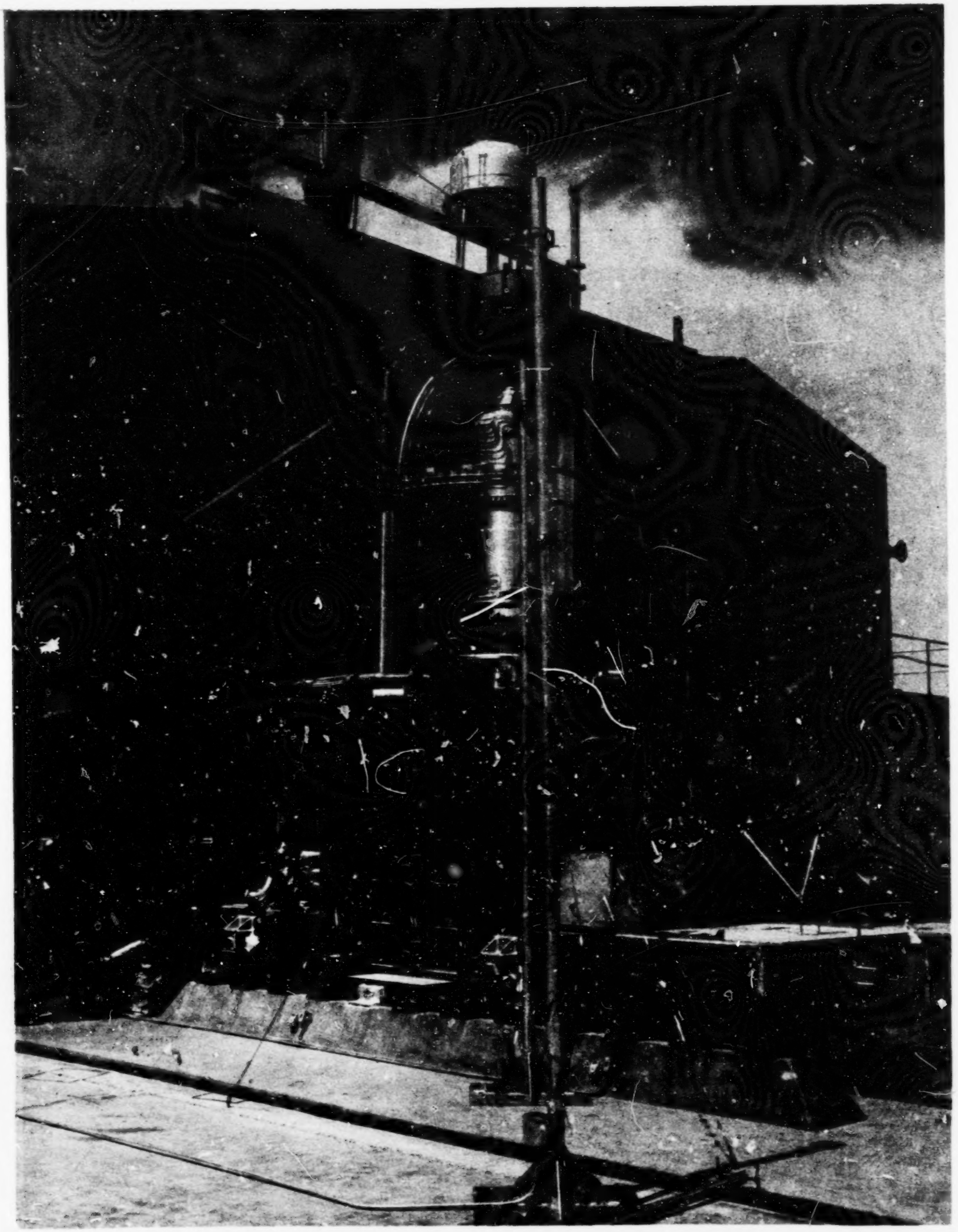

Figure 1. Reactor in testing position.

I. OPERATIONAL PROCEDURES

A. EXTERNAL MEASUREMENTS

1. Ground Monitoring

Ground monitors tracked the reactor effluent passage with portable instruments. Each monitor was equipped with an Eberline E-500B, a Precision Model 111 Standard "Scintillator", and a Victoreen Radector Model No. AGB-50B-SR.

The Eberline E-500B has a range of 0 to 200 milliroentgens per hour (mR/hr) in four scales with an external halogen filled GM tube and a 0 to 2000 mR/hr range from an internal Anton 302 tube. The Precision Model 111 "Scintillator" is used primarily for low level detection and has a range of 0 to 5 mR/hr in six scales. The Radector has a range of 0 to 50,000 mR/hr on two scales. This instrument employs an inert gas ionization chamber. Errors associated with these instruments are of the order of $\pm$20%.

2. Dose Rate Recorders

Eberline RM-11 dose rate recorders are placed at twenty-one stations around the test range complex. These recorders utilize a Geiger tube detector to document radiation levels at specific locations. The instrument has a 0.01 to 100 mR/hr range and the gamma dose rate is recorded on a 30-hour strip chart. The RM-11 is accurate to $\pm$20% as calibrated with a ^{137}Cs source.

3. Aerial Cloud Tracking

An Air Force U3-A aircraft and crew, together with two Public Health Service monitors equipped with portable instruments

identical to those of the ground monitors, tracked the reactor effluent to position ground monitors. Public Health Service cloud sampling aircraft were also used as aids in cloud tracking. Their primary purpose, however, was cloud sampling in order to determine cloud size and inventory. The results of their sampling are reported separately by the SWRHL Engineering Development Program.

4. Film Badges

The PHS maintained 75 film badge stations off the test range complex and assigned badges to 165 off-site residents during the month of April. During May, 62 film badge stations were established and 109 personnel film badges were issued. The badge used is DuPont type 555 film. This film is accurate to $\pm$50% in the 20 to 100 mR range and $\pm$10% in the 100 to 2000 mR range. The lower limit of detectability is 20 mR.

B. ENVIRONMENTAL MEASUREMENTS

1. Air Samples

Ninety-five routine Gelman "Tempest" air samplers were in operation in the western United States. Thirty-two of these are located in Nevada and are presented in Figure 2. Supplementary air samplers were established for the NRX-A3 experiments and their locations are shown in the Results section of each experiment. The "Tempest" air samplers are designed to utilize 4" Whatman No. 541 prefilters and MSA type BM 2306 charcoal cartridge filters. The average flow rate is approximately 10 cfm. The total volume of air sampled is calculated from an average vacuum reading and the total time of sampling.

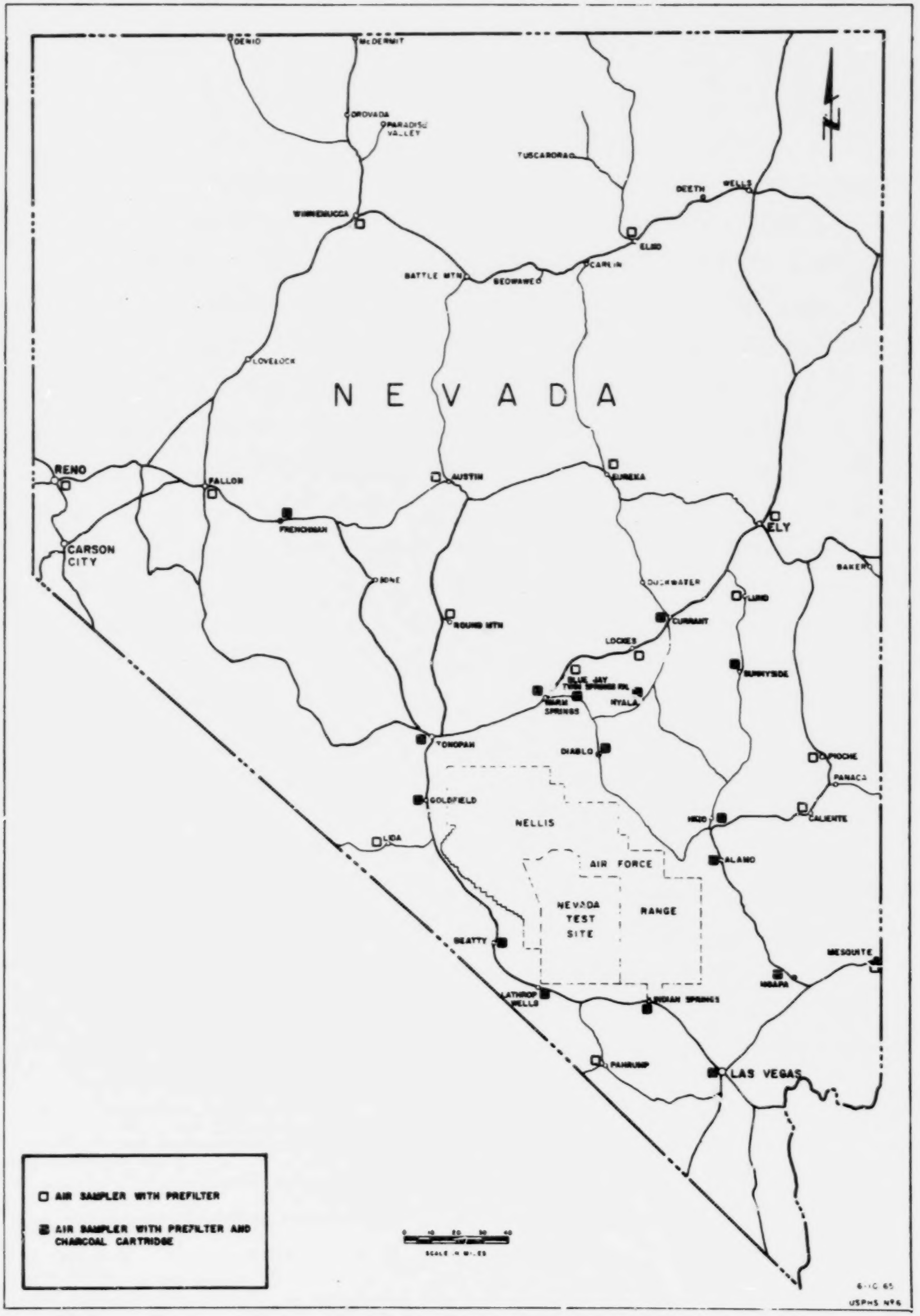

Figure 2. Air surveillance network stations in Nevada.

The prefilters were counted for gross beta and alpha activity with a Beckman wide beta proportional counting system. This system has a detection efficiency of 45% for 0.54 Mev beta particles and has a background of 6 $\pm$ 1 counts per minute.

All air samples were counted for gross beta activity as soon as possible after receipt at SWRHL. Samples which indicated beta concentrations in excess of 20 pCi/m^3 were recounted frequently within the following 48 hour period. These samples were then held for routine counts at 5 and 12 days after collection. The computational procedure employed depends upon the assumption that a decay constant can be found for each individual sample and that this decay constant can then be used to extrapolate the activity to the end of the collection period. For this purpose, the general decay equation $A/A_o = e^{-\lambda t}$ is employed. For samples showing less than 10 pCi/m^3 at time of first count, the 5 and 12 day counts are utilized for computing the decay factor. For sample concentrations exceeding the 10 pCi/m^3 the earlier counts are used for extrapolation purposes.

Since it is not possible to define duration of effluent passage at all locations, the reported values given as pCi/m^3 assume an average concentration over each entire sampling period. Results are also reported in $\frac{\text{pCi-sec}}{m^3}$ to indicate the potential gross beta inhalation exposure at each location. This unit is obtained by multiplying pCi/m^3 by the sampling time in seconds.

All charcoal cartridges were analyzed for gamma isotopes by placing each directly on a 4"x 4" sodium iodide crystal coupled to a 400-channel pulse height analyzer set to view energies from 0 to 2 Mev. The activity on the cartridge should represent the gaseous fission products such as isotopes of iodine. Overall

detection efficiency for this geometry is about 18% at 0.53 Mev (^{133}I). The minimum detectable activity for ^{131}I, ^{132}I, ^{133}I and ^{135}I is about 200 picocuries total on the cartridge, at count time, with an accuracy, at this level, of ±50% for ^{131}I, ^{132}I, ^{133}I, and ±100% for ^{135}I.

2. Milk and Water Samples

After each release of activity from NRDS, milk samples are collected from dairies (processing plants), producing dairy farms, and farms producing milk for their own consumption. Each sample is counted for 50 minutes. No attempt is made to recount samples giving low positive values. The lower limit of detection for gamma emitters in milk samples is 20 picocuries per liter (pCi/l) at time of count, and all results below that value are reported as < 20 pCi/l.

All liquid samples are counted in 3.5 liter inverted well aluminum beakers which are placed on top of a 4"x 4" crystal coupled to a 400-channel gamma pulse height analyzer. Overall detection efficiency for the 0.364 Mev photopeak of ^{131}I is 6.4%. A matrix technique is employed to compute the interference due to the presence of other isotopes. The input to this matrix is variable, allowing for the simultaneous determination of any eight nuclides for which detection efficiencies and interference factors have been obtained. Actual computation is performed by an IBM 1620 computer.

Water samples are analyzed for gross beta activity by slowly evaporating an aliquot to dryness in a 2" diameter stainless steel planchet and counting the beta activity in a low background counter.

Vegetation samples were obtained at all milk sampling locations. An attempt was made to make the samples representative of the cows' feed; however, the samples were taken primarily as early indicators of where milk might be contaminated and were not intended to yield a cow intake-excretion formula.

II. RESULTS

Results of the three NRX-A3 power tests will be reported in separate sections. All of the three experiments yielded low levels of radioactivity off the test range complex.

A. NRX-A3, EP4, April 23, 1965

The reactor was tested at full power for approximately four minutes commencing at 1254 PST. Aerial tracking of the effluent from the test indicated a hot line bearing of 160° from NRDS. Meteorological observations on the test day are presented in Table 1. Environmental sampling locations established after EP4 are shown in Figure 3.

1. Ground Monitoring

Ground monitors detected cloud passage with portable instruments at Pahrump between 1500 and 1545 hours PST. Net peak dose rate during this interval was less than 0.03 mR/hr and occurred at 1530. The external whole body dose due to cloud passage was less than 0.03 millirem.

2. Dose Rate Recorders

Dose rate recorder data collected following EP4 did not indicate dose rates above background.

3. Film Badges

Due to the low dose rates encountered off the test range complex, no off-site film badges were collected immediately following EP4. Badges collected since that time, however, have had no exposure which could be attributed to the EP4 test.

Table 1. Meteorological data supplied by the U.S. Weather Bureau for NRX-A3, EP4.

Sky Condition: Clear Clouds: Cloudless Visibility: Unrestricted
Upper Air Data at: Nuclear Rocket Development Station, 1259 PST, 4/23/65

	Height (Ft. MSL)	Wind (Deg/Kts)	Pressure (mb)	Temperature (^{o}C)	Dew Point (^{o}C)	Relative Humidity (%)
SFC	3615	030/05	895	23.8	- 9.6	10
	3980	100/06	884	21.0	MB	(12)
	5000	100/07	851	17.8	MB	(12)
	5066	100/07	850	17.6	MB	(12)
	5450	090/07	836	16.6	-10.2	15
	6000	090/08	821	14.7	-10.9	16
	7000	070/09	792	11.2	-11.0	20
	7920	060/11	766	8.2	-10.7	25
	8000	060/11	763	8.0	-10.8	25
	9000	050/07	736	5.2	-11.0	30
	10000	070/06	709	2.3	-11.9	34
	10341	040/07	700	1.3	-12.4	35
	11000	360/09	682	-0 6	-13.2	38
	11100	360/09	680	-0.9	-13.1	39
	12000	350/13	656	-2.3	-18.3	28
	12550	340/17	644	-3.1	-21.3	22
	13000	330/22	633	-2.7	MB	(14)
	13080	330/22	631	-2.6	MB	(14)
	13530	320/27	620	-2.9	MB	(14)
	14000	320/26	608	-4.0	MB	(14)
	15000	330/27	586	-6.2	MB	(15)

SFC = Surface
MB = Motor Boating - dewpoint was below the limitations of the instrumentation.
( ) = Numbers in parentheses are the result of calculations based on assumed atmospheric conditions.

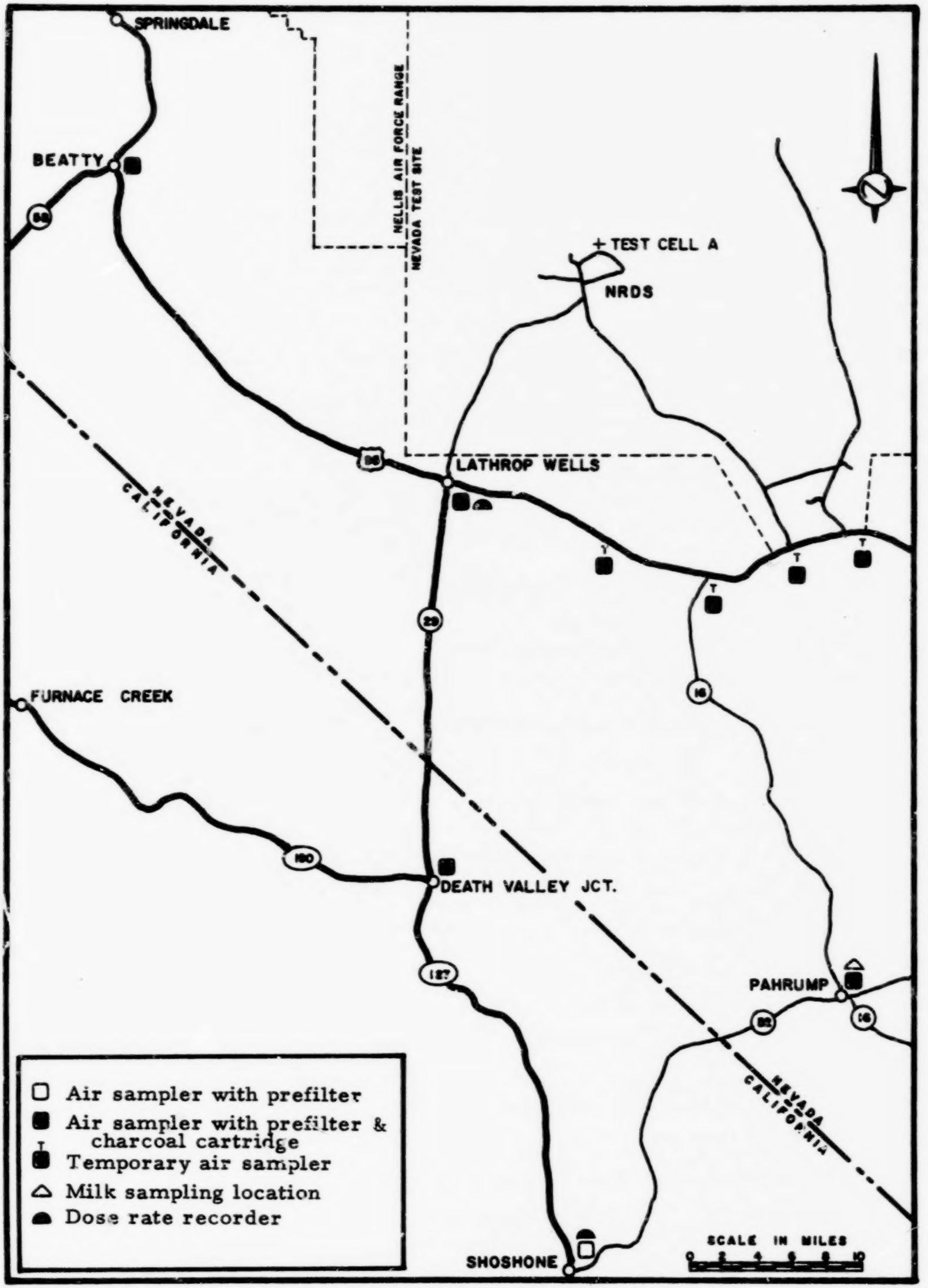

Figure 3. Special sample locations following NRX-A3, EP4.

4. Air Samples

Air samples from several routine stations and four temporary locations were collected following EP4. (See Figure 3). Samples collected following EP4 with gross beta activity above background levels are presented in Table 2. Air samples obtained following EP4 from Beatty, Death Valley Junction and Shoshone, did not indicate gross beta activity above background levels.

5. Milk Samples

A milk sample and a sample of the cow's feed were obtained at Pahrump on the morning of April 24. Analysis of these two samples indicated no radioiodine.

B. NRX-A3, EP5, May 20, 1965

The reactor was conducted at full power in the time interval 1032 to 1046 hours PDT. Aerial tracking of the effluent indicated a hot line bearing lying between 40° and 60° on the test range complex. Meteorological data obtained by the U.S. Weather Bureau is presented in Table 3.

1. Ground Monitoring

Ground monitors located on Highway 25 detected cloud passage with portable instruments. A summary of the ground monitoring data is presented in Table 4. The maximum dose due to cloud passage at any monitored location was less than 0.03 millirem.

2. Dose Rate Recorders

Dose rate recorder data collected from Diablo, Alamo, Pioche and Caliente on the morning of May 21 did not indicate dose rates above background following EP5.

Table 2. Analysis of air samples collected following the NRX-A3, EP4, reported in pCi/m^3 at end of collection.

Location (See Fig. 2)	On Time Date (PST)	Off Time Date (PST)	Volume m^3	Prefilter Gross Beta Concentration pCi/m^3	Integrated Gross Beta Concentration $pCi\text{-}sec/m^3$	Collector	Gamma Pulse Height Analysis pCi/m at End of Collection ^{131}I	^{132}I	^{133}I	^{135}I
Lathrop Wells	1045, 4-23	1555, 4-23	106	3.1	5.9×10^4	P	ND	ND	ND	ND
						C	ND	ND	ND	ND
Hwy. 95, 10 mi ESE of Lathrop Wells	1407, 4-23	1545, 4-23	17	34	2.0×10^5	-	--	--	--	--
Hwy. 95, 17 mi ESE of Lathrop Wells	1350, 4-23	1555, 4-23	20	110	8.4×10^5	-	--	--	--	--
Hwy. 95, 23 mi ESE of Lathrop Wells	1400, 4-23	1600, 4-23	20	4.7	3.4×10^4	-	--	--	--	--
Hwy. 95, 25 mi ESE of Lathrop Wells	1404, 4-23	1605, 4-23	18	36	2.6×10^5	-	--	--	--	--
Pahrump, Nevada	1000, 4-23	1120, 4-24	474	6.3	5.7×10^5	P	2.4	2.8	14	ND
						C	1.2	1.1	3.7	ND

ND = Non Detectable
P = Prefilter
C = Charcoal Cartridge
-- = Not Analyzed

Table 3. Meteorological data supplied by the U.S. Weather Bureau for NRX-A3, EP5.

Sky Condition: High, Thin Broken Clouds: .6 Cirro Stratus
Visibility: Unrestricted
Upper Air Data At: Nuclear Rocket Development Station, 1016 PDT, 5/20/65

	Height (Ft. MSL)	Wind (Deg/Kts)	Pressure (mb)	Temperature (^{o}C)	Dew Point (^{o}C)	Relative Humidity (%)
SFC	3615	190/07	889	23.2	- 5.8	14
	3980	210/02	879	20.9	- 6.7	15
	4000	210/11	878	20.8	- 6.9	15
	4870	210/04	850	18.2	- 6.5	18
	5000	200/05	847	18.0	- 6.7	18
	6000	210/04	816	15.1	- 7.7	20
	7000	280/05	787	12.4	- 8.2	23
	8000	300/06	758	9.6	- 9.5	25
	8740	280/06	738	7.5	-10.8	26
	9000	260/07	731	7.0	-11.2	26
	10000	230/10	704	5.0	-14.0	24
	10180	240/10	700	4.7	-14.2	24
	11000	240/11	679	3.0	-16.1	23
	12000	250/12	654	1.0	-19.0	21
	12230	250/13	648	0.4	-19.5	21
	13000	260/15	630	-1.0	MB	(14)
	14000	280/18	606	-3.0	MB	(14)
	15000	270/20	583	-4.8	MB	(15)

SFC = Surface
MB = Motor Boating - dewpoint was below the limitations of the instrumentation.
( ) = Numbers in parentheses are the result of calculations based on assumed atmospheric conditions.

Table 4. Dose rates occurring off the test range complex on May 20, 1965.

Location (See Figure 4)	Time of Dose Rates Greater Than Background (PDT)	Time of Peak Dose Rate (PDT)	Net Peak Dose Rate (mR/hr)
Goss Ranch	1500 - 1520	1510	< 0.03
Coyote Summit	1455 - 1540	1532	0.06
Hancock Summit	1459 - 1507	1505	< 0.03
Crystal Spring	1525 - 1548	1542	< 0.03

3. Film Badges

Due to the low dose rate encountered off the test range complex, no off-site film badges were collected immediately following EP5. Badges collected since that time, however, have had no exposure which could be attributed to the EP5 test.

4. Air Samples

Air samples from several routine stations and three temporary stations were collected following EP5. (See Figure 4). Samples collected following EP5 that contained fresh fission products are presented in Table 5. Air samples collected from Pioche, Caliente and Warm Springs Ranch did not contain fresh fission products.

5. Milk Samples

Milk samples were obtained following EP5 from Pioche, Caliente, Hiko and Alamo; milk from Hiko contained radioiodine for several weeks following the experiment. Barium-140 was detected on several pasture samples collected in support of the milk sampling program. Since ^{140}Ba is generally not detected off-site from

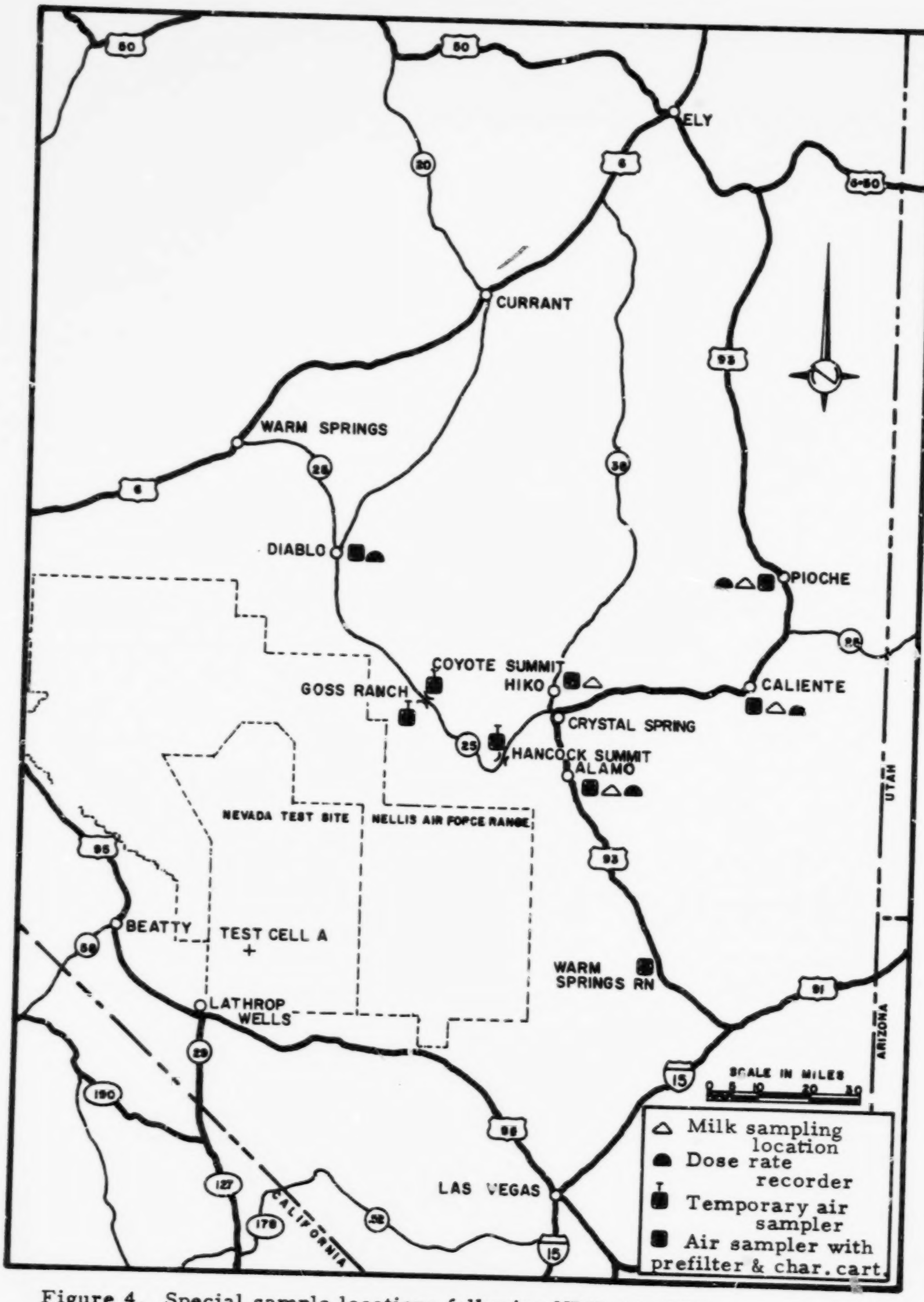

Figure 4. Special sample locations following NRX-A3, EP5.

Table 5. Analysis of air samples collected following the NRX-A3, EP5, reported in pCi/m^3 at end of collection.

Location (See Fig. 4)	On Time Date (PDT)	Off Time Date (PDT)	Volume m^3	Prefilter Gross Beta Concentration pCi/m^3	Integrated Air Concentration $pCi\text{-}sec/m^3$	Col-lector	Gamma Pulse Height Analysis pCi/m at end of collection ^{131}I	^{132}I	^{133}I	^{135}I
Diablo	0655, 5-20	0700, 5-21	487	22	1.9×10^6	P	ND	3.3	0.82	ND
						C	ND	ND	ND	ND
Goss Ranch	1330, 5-20	1600, 5-20	45	76	6.8×10^5	P	12	13	18	9.3
						C	2.4	ND	ND	3.4×10^2
Coyote Summit	1326, 5-20	1607, 5-20	27	290	2.8×10^6	P	41	48	100	67
						C	41	33	67	41
Hancock Summit	1330, 5-20	1605, 5-20	26	88	8.3×10^5	P	15	15	30	17
						C	5.8	ND	ND	21
Hiko	0805, 5-20	1700, 5-20	201	41	1.3×10^6	P	7.0	7.0	7.0	ND
						C	0.95	1.0	1.7	ND
Alamo	0710, 5-20	1700, 5-20	203	38	1.3×10^6	P	4.6	5.4	0.94	ND
						C	ND	ND	ND	ND

ND = Non Detectable
P = Prefilter
C = Charcoal Cartridge

NRDS activities, it is believed that this contamination is due to another nuclear event. Furthermore, ^{131}I was contained in milk collected around May 25 from the Pasteurized Milk Network throughout the United States. Analysis of the data indicate the generalized contamination to be due to fallout from a Chinese nuclear detonation on May 14, 1965. Analysis of milk samples is presented in Table 6.

Table 6. Analysis of milk samples collected following EP5.

Location	Date Collected	Presence of Radioiodine in Feed	Milk Radioassay Data - pCi/l ^{131}I
Horlacher Ranch Pioche, Nevada	5/21/65	ND	ND
Young Ranch Caliente, Nevada	5/21/65	ND	ND
Stewart Dairy Alamo, Nevada	5/21/65	ND	ND
	5/24/65	ND	ND
Schofield Dairy Hiko, Nevada	5/21/65	P	ND
	5/24/65	P	50
	5/26/65	--	70
	5/28/65	P	50
	6/02/65	--	60
	6/08/65	P	90
	6/16/65	P	60
	6/25/65	ND	30

ND = Non Detectable
P = Present
-- = Sample not Obtained

Samples collected after 6/25/65 reflected contamination due to Phoebus 1A effluent passage. The sample analyses are reported in "Final Report of Off-Site Surveillance for the Phoebus 1A Experiment", SWRHL-19r.

C. NRX-A3, EP6, May 28, 1965

The reactor was tested at intermediate power levels in the approximate time interval 1030 to 1100 hours PDT. Aerial tracking of the effluent indicated a hot line bearing of 250° on NRDS. Meteorological observations on the test day are presented in Table 7.

1. Ground Monitoring

Ground monitors did not detect dose rates greater than background on the test day. Monitored locations included Lathrop Wells, Beatty, and Highway 95 between these towns.

2. Dose Rate Recorders

Dose rate recorder data from Lathrop Wells and Beatty did not indicate dose rates greater than background on the day and night of May 28.

3. Film Badges

Since no dose rates greater than background were encountered off the test range complex, no off-site film badges were collected immediately following EP6. Badges collected since that time, however, have had no exposure which could be attributed to the EP6 test.

4. Air Samples

Air samples were collected from the Lathrop Wells and Beatty routine stations and from one temporary station following EP6. (See Figure 5). Of the air samples collected following EP6, only the Lathrop Wells charcoal cartridge contained radioiodine. A summary of the results is shown in Table 8.

5. Milk Samples

Milk samples were obtained at two locations following EP6. Sample analyses are reported in Table 9.

Table 7. Meteorological data supplied by the U.S. Weather Bureau for NRX-A3, EP6.

Sky Condition: Clear Clouds: Cloudless Visibility: Unrestricted
Upper Air Data at: Nuclear Rocket Development Station, 1030 PDT, 5/28/65

	Height (Ft. MSL)	Wind (Deg/Kts)	Pressure (mb)	Temperature (^{o}C)	Dew Point (^{o}C)	Relative Humidity (%)
SFC	3615	080/12	895	25.4	- 2.2	16
	4000	090/13	882	21.5	- 6.2	15
	4980	090/13	850	17.8	- 6.2	19
	5000	090/12	849	17.7	- 6.3	19
	6000	080/12	818	14.8	- 6.7	22
	6726	050/11	798	13.0	- 7.1	24
	7000	020/08	790	12.3	- 7.7	24
	8000	020/09	761	10.0	- 8.7	26
	9000	330/09	734	7.7	-10.2	27
	10000	340/03	706	5.2	-10.6	31
	10295	350/04	700	4.6	-10.7	32
	11000	040/09	681	2.6	-11.3	35
	12000	040/07	655	-0.2	-12.2	40
	13000	020/09	631	-3.4	-12.3	50
	13287	020/09	624	-4.3	-12.7	52
	14000	030/05	607	-4.9	-18.0	35
	15000	310/05	585	-5.9	MB	(15)

SFC = Surface
MB = Motor Boating - dewpoint was below the limitations of the instrumentation.
( ) = Numbers in parentheses are the result of calculations based on assumed atmospheric conditions.

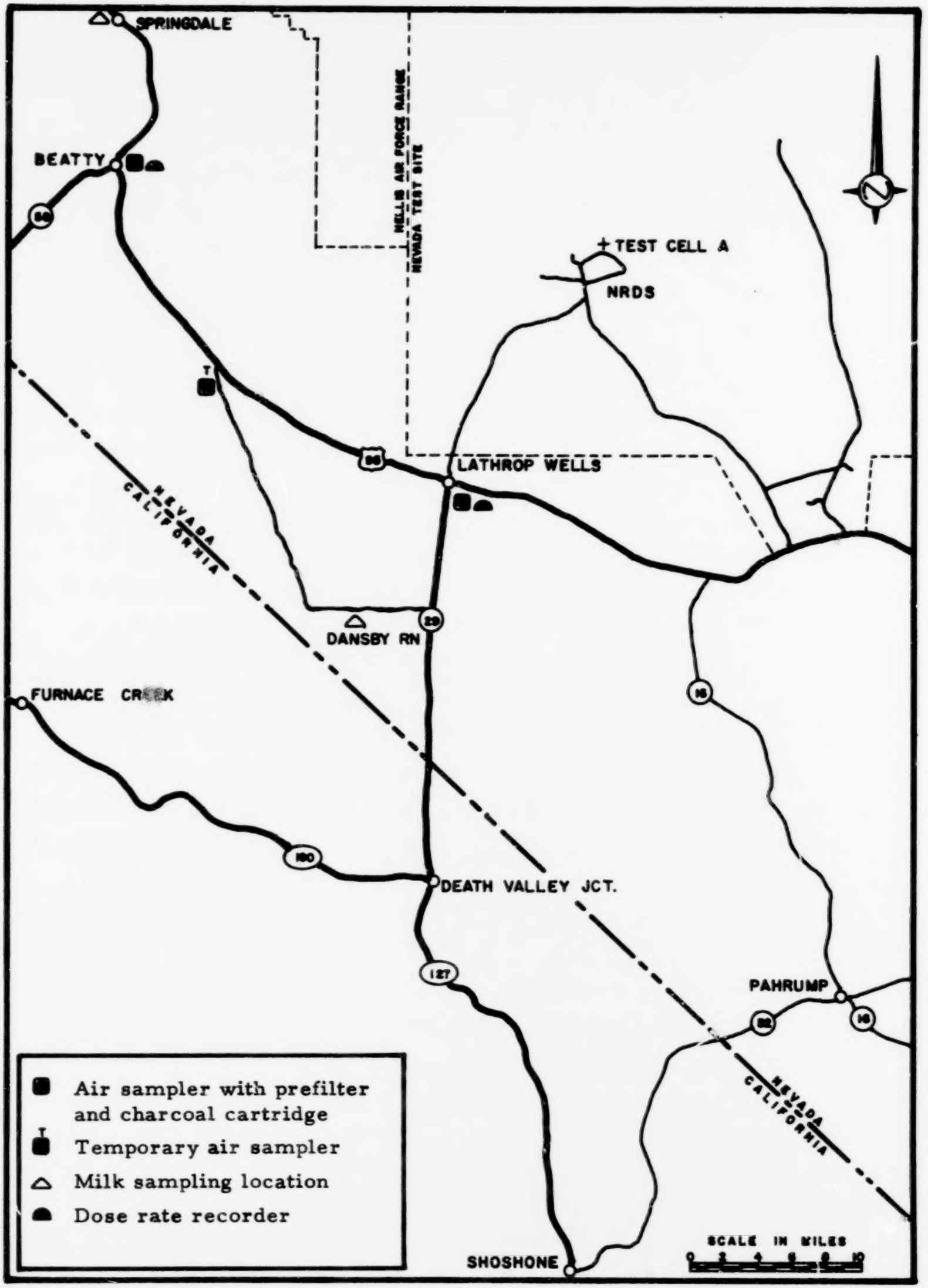

Figure 5. Special sampling locations following NRX-A3, EP6.

Table 8. Analysis of air samples collected following the NRX-A3, EP6, reported in pCi/m³ at end of collection.

Location (See Fig. 5)	On Time Date (PDT)	Off Time Date (PDT)	Volume m³	Prefilter Gross Beta Concentration pCi/m³	Integrated Air Concentration pCi-sec/m³	Collector	Gamma Pulse Height Analysis pCi/m at end of collection ^{131}I	^{132}I	^{133}I	^{135}I
Lathrop Wells	0735, 5-28	1350, 5-28	117	.51	1.2×10^4	P	--	--	--	--
						C	ND	ND	ND	ND
	1355, 5-28	0635, 5-29	342	.54	3.2×10^4	P	ND	ND	ND	ND
						C	0.6	ND	0.7	ND
Hwy. 95, 15 mi W of Lathrop Wells	1055, 5-28	1335, 5-28	27	11	1.1×10^5	P	ND	ND	ND	ND
						C	ND	ND	ND	ND
Beatty	0722, 5-28	1353, 5-28	137	.47	1.1×10^4	P	--	--	--	--
						C	ND	ND	ND	ND
	1353, 5-28	0855, 5-29	315	--	--	P	--	--	--	--
						C	ND	ND	ND	ND

P = prefilter; C = charcoal cartridge
ND = Non Detectable
-- = Not Analyzed

6. Vegetation Samples

Vegetation samples were collected in the area southwest of the NRDS before and after the test. Analyses of these samples indicated that contamination of the area existed before the experiment and that levels were not appreciably increased.

Table 9. Analysis of milk samples collected following EP6.

Location (See Figure 5)	Date Collected	Presence of Radioiodine in Feed	Milk Radioassay Data - pCi/l	
			^{131}I	^{133}I
Dansby Ranch	6/03/65	--	ND	ND
Peacock Ranch Springdale, Nevada	5/29/65	P	ND	ND
	6/03/65	--	70	ND
	6/09/65	--	40	ND
	6/17/65	P	50	ND
	6/25/65	ND	--	--
	7/07/65	--	ND	ND

ND = Non Detectable
-- = Sample not Obtained
P = Present

III. CONCLUSIONS

The effluents from the NRX-A3 Experimental Plans 4, 5 and 6 were detected off the test range complex. The levels represented small fractions of the guides cited in the AEC Standards for Radiation Protection.[1]

The radiation dose standard for external whole body exposure to an individual is 500 millirem per year. The peak external gamma doses detected following Experimental Plans 4 and 5 are presented in Table 10. As seen from the table, the exposures were small compared to the protection guide. As mentioned previously, dose rates greater than background were not detected off-site following Experimental Plan 6.

Table 10. Peak external gamma doses detected off the test range complex following NRX-A3, EP4 and 5.

Test	Location (See Figures 3 and 4)	Dose Millirem
EP4	Pahrump, Nevada	< 0.03
EP5	Coyote Summit (unpopulated)	< 0.03

Since the dose rates at monitored locations returned to background following cloud passage, it is assumed that the infinite exposure at the locations due to ground deposition was negligible.

Peak iodine air concentrations as measured by charcoal cartridges off the test range complex are presented in Table 11. The values

[1] U.S. Atomic Energy Commission Manual Chapter 0524, Standards for Radiation Protection

may be compared to the AEC Standards for soluble iodine concentrations, which are also presented. The standards represent concentrations of radioactivity that should not be exceeded on a continual basis. For the purpose of applying these standards, radioactivity concentrations in effluents may be averaged over periods up to one year.

Table 11. Peak iodine concentrations as measured by charcoal cartridges.

Test	Location (See Figs. 3, 4 and 5)	Gamma pulse height analysis pCi/m^3 at end of collection			
		^{131}I	^{132}I	^{133}I	^{135}I
EP4	Pahrump	1.2	1.1	3.7	ND
EP5	Coyote Summit (unpopulated)	41	33	67	41
EP6	Lathrop Wells	0.6	ND	0.7	ND
AEC air concentration protection standards		$1x10^2$	$8x10^3$	$1.x10^3$	$4x10^3$

By applying conversion factors developed by Ralph S. Decker[2], one may estimate the thyroid dose due to inhalation of radioiodines, assuming a person was present during cloud passage. The factors are applied to charcoal-measured peak radioiodine values from Tables 2, 5 and 8. Picocurie-seconds/meter^3 are obtained by multiplying the sampling time in seconds by the reported pCi/m^3 value. The data are presented in Table 12.

The AEC standard for thyroid exposure is 1500 millirem per year to an individual. The calculated values presented are negligible when compared to the standards.

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2 Estimate of Thyroid Dose Due to Inhalation During Cloud Passage, Ralph S. Decker, Chief, Safety Branch, Space Nuclear Propulsion Office - unpublished report, June 1965.

Table 12. Thyroid dose due to inhalation.

Test	Location (See Figs. 3, 4 and 5)	Conversion Factors ^{131}I $\frac{3.42\times10^{-7}\text{millirad}}{\text{pCi-sec/m}^3}$		Conversion Factors ^{133}I $\frac{9.21\times10^{-8}\text{millirad}}{\text{pCi-sec/m}^3}$		Thyroid dose due to Inhalation of ^{131}I and ^{133}I millirad
		$\frac{\text{pCi-sec}}{\text{m}^3}$	millirad to thyroid	$\frac{\text{pCi-sec}}{\text{m}^3}$	millirad to thyroid	
EP4	Pahrump	1.1×10^5	< 0.1	3.4×10^5	< 0.1	< 0.1
EP5	Coyote Summit (unpopulated)	4.0×10^5	0.14	6.5×10^5	< 0.1	< 0.2
EP6	Lathrop Wells	3.6×10^4	< 0.1	4.2×10^4	< 0.1	< 0.1

Milk sampling following Experimental Plans 5 and 6 indicated contamination due to NRX-A3 effluent. In each case, milk from one of the sampled locations indicated radioiodine concentrations. As seen in Tables 6 and 9, the levels did not exceed 100 pCi/l of ^{131}I. The values may be compared to guidance provided by the Federal Radiation Council (FRC) Report No. 2[3]. An average daily intake of 100 pCi of ^{131}I will meet the FRC Radiation Protection Guide of 0.5 rem/year to the thyroid for averages of suitable samples of an exposed population group. Since the milk sample analyses did not exceed 100 pCi/l ^{131}I and levels were above background for approximately one and 1/2 months, it is concluded that a negligible portion of 0.5 rem was presented to the public.

[3] "Background Material for the Development of Radiation Protection Standards" Report No. 2 of the Federal Radiation Council, Sept. 1961.